Critical Path Analysis
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Executive Summary

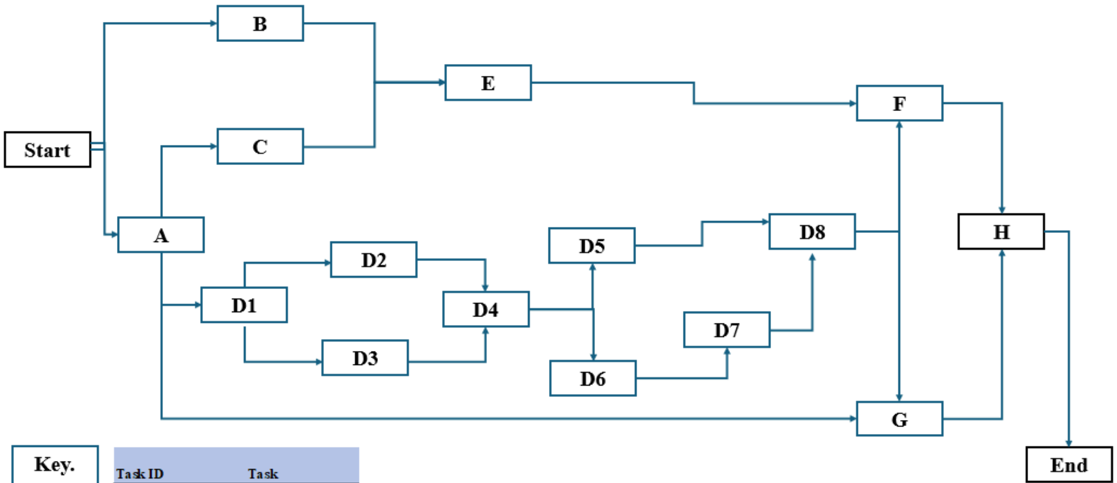
Linear programming was applied to determine the shortest path(s) for a network/critical path analysis (i.e., what is the shortest amount of time required to complete the project and what tasks are involved in that path?). The aim of the project was to build a customer-focused recommender system of reviews. Building such a system required a team of five people composed of a project manager, front end developer, back end developer, data scientist, and data engineer. The team will complete 15 tasks that included 1) describing the product, 2) developing a marketing plan, 3) designing a brochure, 4) requirement analysis, 5) software design, 6) system design, 7) coding, 8) documentation, 9) unit testing, 10) system testing, 11) packaging deliverables, 12) market surveying, 13) developing a pricing plan, 14) developing an implementation plan, and 15) writing a client proposal.

The analysis utilized three time estimates where the first analysis was conducted using best-case hour scenario, then with expected-case hour scenario, and followed with a worst-case hour scenario. In short, the amount of hours that each task was estimated to require to complete increased across analyses respectively.

Overall, this project is estimated to last nearly a year or up to three years in a worst case scenario. The analyses suggested that the shortest amount of time to complete building and implementing a customer-focused recommender system of reviews would take 310 days. At an assumed equal rate of pay per team member of $45 per hour, this amounts to at least $111,600 (310 days * 8 hours per day * $45 per hour). The expected case was suggested to last 620 days and cost at least $223,200. The worst case scenario was suggested to last 970 days, which amounted to at least $349,200.

Two paths were identified given the input parameters and constraints:

1) START → A → C → E → F → H → END
2) START → B → E → F → H → END



Key.

Task ID	Task
A	Describe product
B	Develop marketing strategy
C	Design brochure
D	Develop product prototype
D1	Requirements analysis
D2	Software design
D3	System design
D4	Coding
D5	Write documentation
D6	Unit testing
D7	System testing
D8	Package deliverables
E	Survey potential market
F	Develop pricing plan
G	Develop implementation plan
H	Write client proposal

Method

The goal of this analysis was to find the shortest path in a critical path analysis. Identifying the shortest path or the critical path means identifying the tasks that would take the shortest amount of time with respect to dependencies to complete the project. All analyses were conducted in Spyder/Python using the *pulp* package.

Table 1.

Task ID	Task	Predecessor Task IDs	Project Manager	Frontend Developer	Backend Developer	Data Scientist	Data Engineer	Best Hours	Expected Hours	Worst Hours
A	Describe product		2					2	4	6
B	Develop marketing strategy		4					4	8	12
C	Design brochure	*A*	8					8	16	24
D	Develop product prototype									
D1	Requirements analysis	*A*		2	2	2	2	8	16	24
D2	Software design	*D1*		2	2	2	2	8	16	24
D3	System design	*D1*		2	2	2	2	8	16	24
D4	Coding	*D2, D3*		20	20	60	60	160	320	480
D5	Write documentation	*D4*		4	4	4	4	16	32	48
D6	Unit testing	*D4*		5	5	5	5	20	40	60
D7	System testing	*D6*		5	5	5	5	20	40	60
D8	Package deliverables	*D5, D7*		3	3	3	3	12	24	36
E	Survey potential market	*B, C*	20					20	40	60
F	Develop pricing plan	*D8, E*	10					10	20	30
G	Develop implementation plan	*A, D8*	30			5	5	40	80	120
H	Write client proposal	*F, G*	40					40	80	120

First, hourly duration estimates were determined under a best case, expected case, and worst case scenarios (see Table 1) . In this exercise, best case estimates were developed; expected case estimates were double the values of the best case estimates; and worst case estimates were triple the values of the best case estimates. The hourly rate was assigned an equal value of $45 per hour for all team members (see Table 2).

Table 2.

Role:	Pay Per Hour (in Dollars)
Project Manager	45
Frontend Developer	45
Backend Developer	45
Data Scientist	45
Data Engineer	45

The objective of the project was to find the minimal time/cost, thus a minimization problem. In this case, the objective function consists of the end times of the activities. Thus the objective function was determined to be:

Minimize

Z = 1(A end time) + 1(B end time) + 1(C end time) + 1(D1 end time) + 1(D2 end time) + 1(D3 end time) + 1(D4 end time) + 1(D5 end time) + 1(D6 end time) + 1(D7 end time) + 1(D8 end time) + 1(F end time) + 1(G end time) + 1(H end time)

While this project is estimated to last almost a year, it is likely that this will last at least one year because of missing pieces such as training, delays, and unforeseen events. There is a possibility that delivery of the product may come sooner if independent contractors are hired. There are activities that may benefit from outsourcing such as many of the technical activities and components. While the project activities are estimated to cost a minimum of $111,600, I suggest charging more to offset other direct or indirect costs, and to earn profit.